

**CENTRAL EUROPEAN INITIATIVE
WORKING GROUP ON SCIENCE AND TECHNOLOGY
SECTION C "GEODESY"**

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**NEW PROJECTS
realised
by
16 COUNTRIES OF THE CEI (CENTRAL EUROPEAN INITIATIVE)
WEST SECTION C "GEODESY"**

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Abstract

Report includes concise information on some new GPS geodetic and geodynamic programmes and actions that are realised by the CEI WGST Section C “Geodesy”. The main achievements of the first phase of the international project CERGOP are outlined. The programmes of activities of the Section C Working Group on Satellite Navigation Systems and actions realised by the Working Group on University Education Standards are pointed out. Some cooperation links between CEI WGST Section C “Geodesy” and European Geophysical Society and International Association of Geodesy are given.

1. CURRENT MEMBERSHIP OF THE CENTRAL EUROPEAN INITIATIVE (CEI)

The following 16 European countries are full member countries of the Central European Initiative (status 1 September 1998): Albania, Austria, Belarus, Bosnia&Herzegovina, Bulgaria, Croatia, Czech Republic, Hungary, Italy, Macedonia, Moldova, Poland, Romania, Slovakia, Slovenia and Ukraine. The main objectives of the CEI cooperation are to strengthen the stabilisation within the region of Central Europe, to promote all-European integration processes and to help the Central and Eastern European countries in entering the integrated world by adjusting their multi-lateral relations to European Union's standards.

The Central European Initiative is a loose grouping of states. It was agreed that a Summit (Heads of Governments and Foreign Ministers) Conferences would be held once a year in autumn and a meetings of Foreign Ministers of the member countries would be organised every year in spring. The last Summit Meetings were held in Sarajevo (Bosnia&Herzegovina) in November 1997 and in Brijuni Island (Croatia) in June 1998. Croatia is a chairman of the CEI in 1998.

2. STRUCTURE OF THE ACTIVITIES OF THE CEI WGST SECTION C “GEODESY”

Now the formal structure of the scientific work of the CEI Working Group “Science and Technology” Section C “Geodesy” is the following:

- * Working Group on Interconnection of Geodetic Networks;
- * Working Group on GIS/LIS;
- * Working Group on University Education Standards;
- * Working Group on Satellite Navigation Systems;
- * Project CERGOP (Central Europe Regional Geodynamics Project);
- * Project UNIGRACE (Unification of Gravity Systems in Central and Eastern Europe).

Below there is given a short concise summary of latest news from CEI WGST Section C “Geodesy”, concerning in particular GPS actions and projects.

3. SECOND PHASE OF THE PROJECT CERGOP (Central Europe Regional Geodynamics Project)

The main objectives of the Project are: to integrate the geodynamic research in the region of Central Europe based on high accuracy space geodetic surveys and an integrated geodynamic network and to provide a precise geodetic frame - so called Central European GPS Reference Network (CEGRN) - for studies on geodynamics of Central European particular areas of Pannonia Basin, Bohemian Massif, Teisseyre-Tornquist Zone, Carpathian Orogenic Belt, and Subalpine Region.

The first phase of the Project CERGOP (CERGOP/EU COPERNICUS) was completed on 30 June 1998 and was superseded by a follow-up second phase from 1 July 1998.

Eleven countries participated in the first phase of the CERGOP Project. They are: Austria, Croatia, Czech Republic, Germany, Hungary, Italy, Poland, Romania, Slovakia, Slovenia, Ukraine.

The four CEGRN monitoring campaigns were among the most important activities of the project. Strict rules for the GPS measurements were laid down and followed. To avoid seasonal effects the campaigns were organised yearly in about the same time of the year. Each campaign lasted for five days continuously. The official 31 CEGRN stations took part in the measurements regularly. The following table gives the dates of the monitoring campaigns.

CEGRN Monitoring GPS Campaigns

Campaign	Date
CEGRN' 94 :	2 May - 6 May 1994
CEGRN' 95 :	29 May - 3 June 1995
CEGRN' 96 :	10 June - 15 June 1996
CEGRN' 97 :	4 June - 10 June 1997

Following the monitoring campaigns the data were sent electronically to the CERGOP Data Center in Graz, Austria, where they are made available to all CERGOP processing groups. The observational data of the CEGRN monitoring campaigns were processed in the CERGOP Processing Centers. Originally 3 processing groups were formed (Graz, Austria; Penc, Hungary and Warsaw, Poland). In a later stage of the project the number of processing centers increased to 8 (Bratislava, Slovakia; Frankfurt, Germany; Matera, Italy; Pecny, Czech Republic and Zagreb, Croatia). Most of the processing centers used the BERNESE software package for processing CEGRN data, the Italian group used the GIPSY and the MICROCOSM software packages. Although the large number of processing centres seemed redundant, the independent processing and the experiences gained, resulted in significant benefits for the project. The work of the processing groups were coordinated and evaluated by the Study Group No. 4 chaired by Dr. G. Stangl, Austria.

In 1994/95 a major development of the project was the establishment of CERGOP Study Groups (CSG-s). The groups were formed by the collaboration of scientists from two or more member countries to carry out research in a particular field. Originally 11 CERGOP Study Groups were approved by the IPWG of which 9 remained active during the whole project period. The active study groups are listed below:

CERGOP Study Groups (CSG-s)

- CSG.2 CERGOP site quality monitoring. Chairman: P. Lévai, (Hungary);**
- CSG.3 CERGOP reference frame. Chairman: J. Rogowski, (Poland);**
- CSG.4 Standardisation of data and processing centers. Chairman: G. Stangl, (Austria);**
- CSG.5 Permanent and epoch GPS CERGOP stations. Chairman: J. Śledzinski, (Poland);**
- CSG.6. CEGRN and height determination. Chairman: J. Šimek, (Czech Republic);**
- CSG.7 CERGOP gravity network. Chairman: M. Barlik, (Poland);**
- CSG.8 Geotectonic analysis of the region of Central Europe. Chairman: P.Vyskočil, (Czech Republic) ;**
- CSG.10 Monitoring of recent crustal movements in the Eastern Alps with GPS. Chairman: C. Marchesini, (Italy);**
- CSG.11 Three dimensional plate kinematics in Romania. Chairman: D. Ghițău (Romania).**

As the main achievements of the first phase of the Project CERGOP we can specify the following:

- * establishment and maintenance of the Central European GPS Reference Network consisting of 31 sites on the territories of 11 countries. The sites satisfy the strict requirements for repeated GPS monitoring on the highest accuracy level. They were placed on stable intraplate geological units and suited for long term monitoring. Since 1994 four epoch monitoring campaign have been carried out on this network in yearly intervals.**
- * Eleven CEGRN stations are permanent GPS stations providing continuous monitoring capabilities for tectonic studies. The remaining 20 sites are so called “epoch stations” which give positional information at the measurement epochs.**
- * The sub-centimetre accuracy of the position of the CEGRN stations has been achieved. The results of the processing indicate that an overall site position accuracy of 2-4 mm**

in horizontal coordinates and 4-8 mm in vertical coordinates have been achieved (Stangl et al. 1998.). We can conclude, that the accuracy of CEGRN is equivalent with the highest level, that space techniques can provide today. This achievement was the result of the very complex contributions of design, site monumentation, measurements and processing activities.

- * The Central European Terrestrial Reference Frame (CETRF) has been established, (Rogowski and Hefty, 1998) which suits best for geophysical, geotectonic studies of the region. The yearly monitoring of CETRF provided already significant kinematic results about intraplate tectonic motions in Central Europe (Hefty 1998, Grenerczy and Kenyeres 1998, Fermi et al. 1998). CETRF is homogeneously embedded into the ITRF 94 system, which ensures its global relations. We should point out the important contribution of CETRF not only to geophysical interpretations of the whole region but also to local area deformation studies like the Vrancea area in Romania (Becker et al. 1998) and across the border deformation studies like the Tatra Mountain area (Czarnecki et al. 1998). Further local geodynamical test networks e.g. Grybów/Poland, Pieniny/Poland-Slovakia, Morava/ Slovakia-Czech Rep., Sudety/Poland-Czech Rep. were established and use CETRF to study local geodynamic effects. The CETRF also provides an independent confirmation for kinematic results obtained from national GPS monitoring networks e.g. the HGRN (Grenerczy 1998). The CEGRN network is also to be regarded as a regional subnetwork for monitoring the geodetic reference system in Europe i.e. the European Reference Frame (EUREF). Twenty two stations from CEI countries (eleven CEGRN stations) are used for permanent monitoring of the EUREF (Sledzinski 1998). Several CERGOP Processing Centres (Frankfurt, Pecny, Warsaw) serve also as EUREF Analysis Centres.
- * All results achieved currently by different CERGOP working groups were regular and fast published in the series REPORTS ON GEODESY edited by the Institute of Geodesy and Geodetic Astronomy of the Warsaw University of Technology. Nine volumes of Proceedings of all nine CERGOP Working Conferences are available. The scientific outputs of CSG-s presented at different international conferences should also be mentioned. Perhaps the most notables among them are the five monographs of five particular regions in Central Europe produced by CSG.8 "Geotectonic analysis of the region of Central Europe" (Śledziński and Vyskočil 1998). The following volumes of geotectonic monographs were published in REPORTS ON GEODESY series: The Pannonian Basin (edited by G. Grenerczy), The Bohemian Massif (edited by P. Vyskočil), The Teisseyre-Tornquist Zone (edited by J. Liszkowski), The Northern Carpathians (edited by F. Zablotsky), and The Southern Carpathians (edited by D. Ioane). The monographs summarise the latest geoscience results, available on these regions, with particular emphasis on the project's objectives. There will be a sixth volume by Vyskočil and Sledzinski which will contain general characteristics of all regions, list of performed studies and a summary, indicating some proposals for future investigations.
- * A very active collaboration in the area of space geodesy has been established among the eleven Central European countries. Earlier isolated groups learned to work together and integrated research fields, efforts and resources. Some experts questioned the necessity

of the large number of processing centers (recently there were 8 of them) within one project mainly because they did parallel work. Here we should point out that this was the way that many countries learned the techniques and methods of high precision GPS data processing using data over a large geographic area, experimented with different processing strategies, worked out commonly applied standards and learned from each other. This gave also a self-confidence, that each of them is capable to produce very high accuracy results. From the experiences gained, local area studies will certainly benefit in the future.

- * The project has lead to new initiatives as well. Project UNIGRACE (Unification of Gravity Systems in Central and Eastern Europe), for instance, was launched initially as part CERGOP. Its concept has absorbed many useful features of CERGOP (Reinhart et al 1998).

Considering the future of the Project the following main points can be summarised as follows:

It was clear from the beginning of CERGOP, that a project duration of 3 years, although is sufficient for getting interesting initial results, should be continued for at least another 3-5 years in order to obtain a reliable 3D intraplate tectonic velocity field in the Central European region.

Although the basic objectives of CERGOP will be still valid in the future, shift of the focus and new formulations are necessary. We expect significant changes due to the following factors:

- * Adoption of new member countries (Albania, Bosnia&Herzegovina and Bulgaria), extension of the geographic area of the project;
- * Extension of the CEGRN, adoption of new sites thus establishing the Central European Extended Geodynamic Reference Network (CEEGRN); The “old”, well established 31 sites of CEGRN that represent a great value already by its history of GPS measurements, will be of course preserved;
- * The new role of the permanent stations;
- * The proliferation of local area deformation studies based on the CETRF;
- * Integration processes with other regional networks (e.g. EUREF);
- * Integration into the global networks by using SINEX exchange format;
- * Interaction with other, overlapping projects;
- * Open access to CERGOP data bases and improved information service on the INTERNET.

The main objectives of a future (second phase) project could be formulated as follows:

- * Maintain the Central European Terrestrial Reference Frame (CETRF), which is best suited for regional tectonic investigations;
- * Provide a reliable 3 dimensional tectonic velocity field covering the Central European Region and integrate this into hierarchically higher level (i.e. global) velocity fields and tectonic models;

- * Geophysical interpretation of the three dimensional velocity field;
- * Investigate the most profound large scale geotectonic features in the Central European Region, the Bohemian Massif, the Teisseyre-Tornquist zone, the Carpathian Orogeny, the Carpathian Basin and their relation to the Alpine-Adria region, the Moesian platform and to the Balkanides.
- * Extension of the Central European Regional Geodynamic Network (CEEGRN) to include new, tectonically relevant sites in the area of study, to improve the network configuration stability and to provide a more extended basis for the CETRf;
- * Increase the effectiveness of CEEGRN (Central European Extended GPS Reference Network) by increasing the number of permanent stations in the region.
- * Support local area geodynamic research, environmental studies, seismic hazard assessments, meteorology etc. in the Central European Region based upon the high accuracy space geodetic measurements, carried out on an integrated geodynamic network, the CEEGRN.

4. Programme EXTENDED SAGET

For technical reasons the number of sites of the CEEGRN was limited to 31. It is successfully supplemented by the programme EXTENDED SAGET which was initiated by the Institute of Geodesy and Geodetic Astronomy of the Warsaw University of Technology in 1991 as an extension of the Polish Project SAGET launched at this Institute in 1986. There is a significant coincidence of scientific aims of both projects; however, there are also very essential differences. The EXTENDED SAGET network covers much more extended area and an unlimited number of points can be incorporated to this network. This gives an excellent opportunity to all participating institutions to connect new established points to the ITRF coordinate system. EXTENDED SAGET campaigns are thought as long-term action and will be performed every year at least in the whole of current decade. So far, the EXTENDED SAGET campaigns were organised in the following periods:

- (1) EXTENDED SAGET'1992, September 7-11;
- (2) EXTENDED SAGET'1993, August 2-6;
- (3) EXTENDED SAGET'1994, May 2-6;
- (4) EXTENDED SAGET'1995, May 29 - June 3;
- (5) EXTENDED SAGET'1996, June 10-15;
- (6) EXTENDED SAGET'1997, June 4-10;
- (7) EXTENDED SAGET'1998, June 27 to July 1.

In order to have more points related to the same epoch of observation the four campaigns of EXTENDED SAGET 1994-1997 fully overlapped the period of CEEGRN campaigns. The following conclusions may be pointed out when comparing both projects: (1) The same standards of GPS observations are observed in both CEEGRN and EXTENDED SAGET campaigns, (2) EXTENDED SAGET network includes stations of Scandinavia and Mediterranean Region. CEEGRN is limited only to CEI countries; only some regions of Germany, interesting from tectonic point of view, are included, (3) EXTENDED SAGET campaigns give the possibility to connect to ITRF system new points that may be currently needed, (4) Both networks (projects) can coexist. Campaigns of both projects may supplement each other.

5. ACTIVITY OF THE SECTION C WORKING GROUP ON UNIVERSITY EDUCATION STANDARDS

The Section C Working Group on University Education Standards is chaired by Profs. K. Czarnecki/Poland and F. Vodopivec/Slovenia. The general charter duties of this Working Group are the following:

- (a) unification of university programmes and curricula,
- (b) compatibility of programmes of universities from Central and Eastern Europe and those from Western countries,
- (c) exchange of scientists and lecturers, organisation of postgraduate and doctoral studies, summer/winter schools, etc.
- (d) exchange of student groups with the aim of field training in surveying and geodesy, diploma works, scientific visits etc.,
- (e) cooperation with similar Working Groups of IAG and FIG,
- (f) initiation of international projects (TEMPUS, PHARE, COPERNICUS etc.).

This group organised successfully some international GPS meetings: in 1996 an "International Symposium on Education in GPS Application to Geodesy and GIS" and in 1997 a symposium "International Symposium on DGPS in Engineering and Cadastral Measurements Education and Practice", both held in Ljubljana/Slovenia.

Next action of this group, a Summer Seminar "Education in GPS Application to Geodesy and GIS/LIS", was organised in June 1998 Grybow, Poland. Participants from Austria, Germany, Hungary, Poland, Slovakia and Slovenia attended the Seminar. It was recommended that in the next years the training on GPS techniques and applications for the international student groups would be organised in Grybów, Poland. The participants from all 16 CEI countries are invited to attend the training meetings.

6. CEI SECTION C WORKING GROUP ON SATELLITE NAVIGATION SYSTEMS

In view of a great development of navigation systems (various geodetic real time and postprocessing positioning systems, DGPS, DGLONASS etc.) in many CEI countries the Section C has decided to establish a new Section Working Group on Satellite Navigation Systems. The Chairman of this Working Group was elected Prof. Dr. Stanislaw Oszczak (Poland), the Co-Chairman - Prof. Dr. Giorgio Manzoni (Italy). The plan of international actions and cooperation of this Working Group is now being developed by the chairmen of the Working Group. First working meeting of this international group was held in Nice (France) in April 1998 on the occasion of the EGS General Assembly and the EGS Symposium "Geodetic and Geodynamic Achievements of the CEI (Central European Initiative)". Next meeting is planned by the end of 1998.

7. COOPERATION BETWEEN CEI SECTION C AND IAG (INTERNATIONAL ASSOCIATION OF GEODESY)

To create a better cooperation and coordination of the scientific projects related to the area of Central Europe the Subcommittee "Geodetic and Geodynamic Programmes of the CEI" was created in 1996 within the IAG Commission VII "Recent crustal movements", Section V "Geodynamics" as a result of the request of the International Coordinator of the CEI Section C "Geodesy". The Chairman of the Subcommittee was elected Prof. Dr. J. Sledziński (Poland). The following charter duties of the Subcommittee are the following:

- * coordination and/or integration of the international geodetic and geodynamic programmes supported by IAG and CEI,
- * creation of close links between running projects of IAG and those of CEI (e.g. CEI CERGOP - Central Europe Regional Geodynamics Project and IGS and EUREF, use of CEI permanent GPS stations within IGS and other programmes for maintenance of the ETRF and ITRF, etc.),
- * initialisation of common geodetic and geodynamic projects for the region of Central and Eastern Europe,
- * fostering the cooperation among universities and research centres from Central Europe and Western countries in the field of geodesy and geodynamics, promoting actions contributing to the development of innovative technologies and participation of CEI scientists in international IAG research programmes.

The exhaustive Progress Report on activities of the IAG Subcommittee "Geodetic and Geodynamic Programmes of the CEI (Central European Initiative)" was presented by the chairman at the IAG Scientific Assembly, Rio de Janeiro, Brazil, 3-9 September 1997.

8. COOPERATION BETWEEN CEI SECTION C "GEODESY" AND EGS (EUROPEAN GEOPHYSICAL SOCIETY) SECTION 2 "GEODESY"

Since there are many projects of common interest of both CEI and EGS, it was decided during the XXI EGS General Assembly in the Hague (The Netherlands) that during the next XXII General Assembly of the European Geophysical Society, Vienna, Austria, 21-25 April 1997 a special symposium devoted to geodetic and geodynamic programmes of the CEI would be held. The Convener of the Symposium Prof. Dr. J. Śledziński (Poland) was elected. Next EGS Symposium "Geodetic and Geodynamic Achievements of the CEI (Central European Initiative)" was organised at the XXIII General Assembly of the EGS in Nice in April 1998. The Convener of this Symposium was Prof. Dr. Janusz Sledziński (Warsaw, Poland) and the Co-Convener Prof. Dr. Jan Kostecky (Prague, the Czech Republic). About 45 papers on EUREF campaigns in CEI countries, CERGOP, UNIGRACE, activities of the CSGs, contribution of permanent GPS stations in CEI countries to international programmes, etc. were presented at the oral and poster sessions of the symposia. The next EGS symposium "Geodetic and Geodynamic Programmes of the CEI" will be held in April 1999 in The Hague (The Netherlands) as one of the symposia of the XXIV General Assembly of the European Geophysical Society EGS.

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